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DATE: Wednesday, August 17, 2005

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<input type="checkbox"/>	L15	L14 and oxygen	12
<input type="checkbox"/>	L14	L13 and steam reform\$3	12
<input type="checkbox"/>	L13	L12 and hydrogen with fuel	12
<input type="checkbox"/>	L12	L11 not l6	12
<input type="checkbox"/>	L11	L10 and synthesis gas	14
<input type="checkbox"/>	L10	L9 or l8	15
<input type="checkbox"/>	L9	pressure swing reform\$3	15
<input type="checkbox"/>	L8	pressure swing reformer	11
<input type="checkbox"/>	L7	l5 not l6	28
<input type="checkbox"/>	L6	L5 and steam with compressor	3
<input type="checkbox"/>	L5	L4 and synthesis gas	31
<input type="checkbox"/>	L4	separated hydrogen with fuel	244
<input type="checkbox"/>	L3	L1 and hydrogen same fuel	1
<input type="checkbox"/>	L2	L1 and hydrogen with fuel	0
<input type="checkbox"/>	L1	6512018.pn.	2

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=> FIL STNGUIDE

COST IN U.S. DOLLARS	SINCE FILE ENTRY	TOTAL SESSION
FULL ESTIMATED COST	0.21	0.21

FILE 'STNGUIDE' ENTERED AT 10:45:12 ON 17 AUG 2005

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LAST RELOADED: Aug 12, 2005 (20050812/UP).

=> FIL HOME

COST IN U.S. DOLLARS	SINCE FILE ENTRY	TOTAL SESSION
FULL ESTIMATED COST	0.06	0.27

FILE 'HOME' ENTERED AT 10:45:19 ON 17 AUG 2005

=> file caplus

COST IN U.S. DOLLARS	SINCE FILE ENTRY	TOTAL SESSION
FULL ESTIMATED COST	0.21	0.48

FILE 'CAPLUS' ENTERED AT 10:45:36 ON 17 AUG 2005

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FILE LAST UPDATED: 16 Aug 2005 (20050816/ED)

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This file contains CAS Registry Numbers for easy and accurate substance identification.

=> s pressure swing reform?
 1130261 PRESSURE
 167994 PRESSURES
 1193950 PRESSURE
 (PRESSURE OR PRESSURES)
 7074 SWING
 761 SWINGS
 7751 SWING
 (SWING OR SWINGS)
 45292 REFORM?
 L1 10 PRESSURE SWING REFORM?
 (PRESSURE (W) SWING (W) REFORM?)

=> s l1 and synthesis gas
 1197824 SYNTHESIS
 3 SYNTHESISES
 64912 SYNTHESSES
 1234406 SYNTHESIS
 (SYNTHESIS OR SYNTHESISES OR SYNTHESSES)
 1442792 GAS
 492265 GASES
 1618526 GAS
 (GAS OR GASES)
 15761 SYNTHESIS GAS
 (SYNTHESIS (W) GAS)
 L2 9 L1 AND SYNTHESIS GAS

=> s l2 and steam reform?
 198707 STEAM
 432 STEAMS
 199023 STEAM
 (STEAM OR STEAMS)
 45292 REFORM?
 7744 STEAM REFORM?
 (STEAM (W) REFORM?)
 L3 8 L2 AND STEAM REFORM?

=> d l3 ibib ab 1-8

L3 ANSWER 1 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN
 ACCESSION NUMBER: 2005:611848 CAPLUS
 DOCUMENT NUMBER: 143:99286
 TITLE: Methanol manufacture using **pressure-swing reforming**
 INVENTOR(S): Hershkowitz, Frank; Lattner, James R.
 PATENT ASSIGNEE(S): USA
 SOURCE: U.S. Pat. Appl. Publ., 19 pp., Cont.-in-part of U.S.
 Ser. No. 738,782.
 CODEN: USXXCO
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 2
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2005154068	A1	20050714	US 2004-11984	20041214
US 2005137269	A1	20050623	US 2003-738782	20031217
PRIORITY APPLN. INFO.:			US 2003-738782	A2 20031217

AB A process for producing methanol is described in which a hydrocarbon is **steam reformed** in a reforming zone, and during the reforming stage, of a cyclic **steam reformer** having a reforming stage and a regeneration stage, the **steam reforming** being conducted under conditions effective to produce a

first effluent stream containing **synthesis gas** (i.e., a H₂-CO mixture). Fuel and an oxygen-containing gas are combusted in the regeneration stage of the reformer so as to reheat the reforming zone to a temperature sufficient for the reforming stage and generate a flue gas. At least part of the first effluent stream is contacted with a methanol synthesis catalyst under conditions effective to convert **synthesis gas** to methanol and form a methanol-containing stream and a tail gas stream comprising unreacted carbon monoxide and hydrogen. At least part of the tail gas stream is recycled as fuel for the regeneration stage of the cyclic steam reformer. Process flow diagrams are presented.

L3 ANSWER 2 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN
 ACCESSION NUMBER: 2004:802239 CAPLUS
 DOCUMENT NUMBER: 141:262839
 TITLE: Hydrogen manufacture using **pressure swing reforming**
 INVENTOR(S): Hershkowitz, Frank; Segarich, Robert L.
 PATENT ASSIGNEE(S): USA
 SOURCE: U.S. Pat. Appl. Publ., 13 pp., Cont.-in-part of U.S. Ser. No. 756,652.
 CODEN: USXXCO
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 3
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004191166	A1	20040930	US 2004-771919	20040204
US 2004170559	A1	20040902	US 2004-756652	20040113
WO 2004078644	A1	20040916	WO 2004-US4269	20040213
W:	AE, AE, AG, AL, AL, AM, AM, AM, AT, AT, AU, AZ, AZ, BA, BB, BG, BG, BR, BR, BW, BY, BY, BZ, BZ, CA, CH, CN, CN, CO, CO, CR, CR, CU, CU, CZ, CZ, DE, DE, DK, DK, DM, DZ, EC, EC, EE, EE, EG, ES, ES, FI, FI, GB, GD, GE, GE, GH, GM, HR, HR, HU, HU, ID, IL, IN, IS, JP, JP, KE, KE, KG, KG, KP, KP, KR, KR, KZ, KZ, KZ, LC, LK, LR, LS, LS, LT, LU, LV, MA, MD, MD, MG, MK, MN, MW, MX, MX, MZ, MZ, NA, NI			
RW:	BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG			

PRIORITY APPLN. INFO.: US 2003-450903P P 20030228
 US 2004-756652 A2 20040113
 US 2004-771919 A 20040204

AB The invention provides a method for generating high pressure hydrogen at improved thermal efficiencies. First a **synthesis gas** stream at a first pressure is produced in a **pressure swing reformer**. Next the **synthesis gas** stream is subjected to a high temperature water gas shift process to produce a hydrogen enriched stream from which high pressure hydrogen is obtained. Specific embodiments of the invention involve: regenerating the reformer at a pressure lower than the **synthesis gas** generation; operating the **synthesis gas** generation step at conditions sufficient to provide a syn gas stream at a temperature in the range used in the water gas shift reaction; and using pressure swing adsorption to sep. the hydrogen.

L3 ANSWER 3 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN
 ACCESSION NUMBER: 2004:759843 CAPLUS
 DOCUMENT NUMBER: 141:279433
 TITLE: Liquid hydrocarbon synthesis process using

INVENTOR(S): pressure-swing reforming
 Hershkowitz, Frank
 PATENT ASSIGNEE(S): USA
 SOURCE: U.S. Pat. Appl. Publ., 15 pp., Cont.-in-part of U.S.
 Pat. Appl. 2004 170,558.
 CODEN: USXXCO
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 2
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004180973	A1	20040916	US 2004-771920	20040204
US 2004170558	A1	20040902	US 2004-756651	20040113
PRIORITY APPLN. INFO.:			US 2003-450902P	P 20030228
			US 2004-756651	A2 20040113

AB A method is described for producing liquid hydrocarbons by first generating in a pressure-swing reformer a synthesis gas stream having a mole ratio of H₂-CO greater than 2:1. Then, a portion of the hydrogen is separated to produce a synthesis gas stream having a mole ratio of H₂-CO of about 2:1 which steam is then introduced into a hydrocarbon synthesis reactor for conversion to liquid products. Process flow diagrams are presented.

L3 ANSWER 4 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2004:756641 CAPLUS
 DOCUMENT NUMBER: 141:245651
 TITLE: Hydrogen manufacture using pressure swing reforming
 INVENTOR(S): Hershkowitz, Frank; Segarich, Robert L.
 PATENT ASSIGNEE(S): ExxonMobil Research and Engineering Company, USA
 SOURCE: PCT Int. Appl., 34 pp.
 CODEN: PIXXD2
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 3
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
WO 2004078644	A1	20040916	WO 2004-US4269	20040213
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RW: BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG				
US 2004170559	A1	20040902	US 2004-756652	20040113
US 2004191166	A1	20040930	US 2004-771919	20040204
PRIORITY APPLN. INFO.:			US 2003-450903P	P 20030228
			US 2004-756652	A 20040113
			US 2004-771919	A 20040204

AB A method for generating high pressure hydrogen at improved thermal efficiencies is described. First a synthesis gas stream at a first pressure is produced in a pressure swing reformer. Next the synthesis

gas stream is subjected to a high temperature water gas shift process to produce a hydrogen enriched stream from which high pressure hydrogen is obtained. Specific embodiments of the invention involve: regenerating the reformer at a pressure lower than the synthesis gas generation; operating the synthesis gas generation step at conditions sufficient to provide a syngas stream at a temperature in

the

range used in the water gas shift reaction; and using pressure swing adsorption to sep. the hydrogen.

REFERENCE COUNT: 1 THERE ARE 1 CITED REFERENCES AVAILABLE FOR THIS RECORD. ALL CITATIONS AVAILABLE IN THE RE FORMAT

L3 ANSWER 5 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2004:739731 CAPLUS

DOCUMENT NUMBER: 141:209842

TITLE: Pressure swing reforming
to produce hydrogen for fuel cell systems

INVENTOR(S): Hershkowitz, Frank; Berlowitz, Paul J.; Partridge,
Randall D.

PATENT ASSIGNEE(S): USA

SOURCE: U.S. Pat. Appl. Publ., 17 pp.

CODEN: USXXCO

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004175326	A1	20040909	US 2004-756647	20040113
WO 2004078646	A1	20040916	WO 2004-US4265	20040213
W:	AE, AE, AG, AL, AL, AM, AM, AM, AT, AT, AU, AZ, AZ, BA, BB, BG, BG, BR, BR, BW, BY, BY, BZ, BZ, CA, CH, CN, CN, CO, CO, CR, CR, CU, CU, CZ, CZ, DE, DE, DK, DK, DM, DZ, EC, EC, EE, EE, EG, ES, ES, FI, FI, GB, GD, GE, GE, GH, GM, HR, HR, HU, HU, ID, IL, IN, IS, JP, JP, KE, KE, KG, KG, KP, KP, KR, KR, KZ, KZ, LC, LC, LK, LR, LS, LS, LT, LU, LV, MA, MD, MD, MG, MK, MN, MW, MX, MX, MZ, MZ, NA, NI			
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PRIORITY APPLN. INFO.: US 2003-450904P P 20030228
US 2004-756647 A 20040113

AB Hydrogen for the use as fuel in fuel cells is produced by steam reforming a hydrocarbon-containing feed in a 1st zone of a reactor containing a bed packing material and a reforming catalyst, passing at least a portion of the product through a 2nd zone of the reactor containing bed packing material to transfer heat to the packing material, removing the hydrogen-rich product from the 2nd zone, introducing an oxygen-containing gas into the 2nd zone and combusting the gas and a fuel in a region proximate to an interface between the 1st and the 2nd zone to produce heat which is transferred to the 1st zone of the reactor. The catalyst can contain noble metals, group VIII metal components, Ag, Ce, Cu, La, Mo, Mg, Sn, Ti, Y, or Zn. The bed packing material can be magnesium aluminum silicates, aluminum silicate clays, mullite, alumina, silica-alumina, or zirconia. Pressure swing reforming may be integrated with shift reactions, preferential oxidation, and membrane separation, achieving thermal and material efficiencies relative to conventional hydrogen production

L3 ANSWER 6 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2004:722711 CAPLUS

DOCUMENT NUMBER: 141:192839
 TITLE: Hydrogen manufacture using pressure swing reforming
 INVENTOR(S): Hershkwitz, Frank; Segarich, Robert L.
 PATENT ASSIGNEE(S): USA
 SOURCE: U.S. Pat. Appl. Publ., 12 pp.
 CODEN: USXXCO
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 3
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004170559	A1	20040902	US 2004-756652	20040113
US 2004191166	A1	20040930	US 2004-771919	20040204
WO 2004078644	A1	20040916	WO 2004-US4269	20040213

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PRIORITY APPLN. INFO.:
 US 2003-450903P P 20030228
 US 2004-756652 A2 20040113
 US 2004-771919 A 20040204

AB Hydrogen is produced by introducing a feed stream containing a hydrocarbon and steam through a 1st end of a 1st zone containing bed packing materials and a steam reforming catalyst to produce a syngas stream containing H₂, CO, steam, and CO₂, passing the produced syngas stream to a 2nd zone containing bed packing materials thereby transferring heat from the product to the packing materials, removing the product syngas from the 2nd zone and passing it to a water gas shift reactor to convert CO with steam to CO₂ and H₂, introducing the obtained H₂-enriched stream to a pressure swing adsorption apparatus to sep. H₂ from a byproduct stream, introducing an oxygen-containing gas into the 2nd end of the 2nd zone, and contacting it with fuel to reheat the 1st zone with the heat of combustion and creating a flue gas which exits through the 1st end of the 1st zone. The packing material of the 1st and 2nd zones can be aluminum magnesium silicates, clays, silica-alumina, or zirconia.

L3 ANSWER 7 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2004:722710 CAPLUS
 DOCUMENT NUMBER: 141:209840
 TITLE: Hydrocarbon synthesis process using syngas from pressure swing reforming
 INVENTOR(S): Hershkwitz, Frank
 PATENT ASSIGNEE(S): USA
 SOURCE: U.S. Pat. Appl. Publ., 14 pp.
 CODEN: USXXCO
 DOCUMENT TYPE: Patent
 LANGUAGE: English
 FAMILY ACC. NUM. COUNT: 2
 PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2004170558	A1	20040902	US 2004-756651	20040113

US 2004180973	A1	20040916	US 2004-771920	20040204
WO 2004078880	A2	20040916	WO 2004-US4270	20040213
WO 2004078880	A3	20050407		

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RW: BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG, BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG

PRIORITY APPLN. INFO.: US 2003-450902P P 20030228
US 2004-756651 A2 20040113

AB Liquid hydrocarbons are produced by (a) generating a **synthesis** gas stream having a mole ratio of H₂:CO >2:1 in a **pressure swing reformer** with a 1st zone containing bed packing materials, (b) passing a portion of the product to a 2nd zone containing bed packing materials to transfer heat from the product to the packing material, (c) removing the product stream from the 2nd zone, (d) introducing an oxygen-containing gas into a 2nd end of the 2nd zone to combust a fuel thereby reheating the 1st zone to reforming temperature and creating a flue gas which exits the 1st end of the 1st zone, (e) separating a portion of hydrogen from the product recovered in (c) to produce a **synthesis** gas stream having a H₂:CO ratio of about 2:1, (f) using separated H₂ as fuel in step (d), and (g) introducing the **synthesis** gas of step (e) into a hydrocarbon synthesis reactor.

L3 ANSWER 8 OF 8 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2003:1007569 CAPLUS
DOCUMENT NUMBER: 140:29338
TITLE: Pressure swing reforming to produce **synthesis** gas
INVENTOR(S): Hershkowitz, Frank; Deckman, Harry W.
PATENT ASSIGNEE(S): USA
SOURCE: U.S. Pat. Appl. Publ., 10 pp.
CODEN: USXXCO
DOCUMENT TYPE: Patent
LANGUAGE: English
FAMILY ACC. NUM. COUNT: 1
PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
US 2003235529	A1	20031225	US 2003-458399	20030610
CA 2491231	AA	20031231	CA 2003-2491231	20030624
WO 2004000725	A1	20031231	WO 2003-US20792	20030624
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BR 2003012076	A	20050322	BR 2003-12076	20030624
EP 1530549	A1	20050518	EP 2003-761354	20030624
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PRIORITY APPLN. INFO.:

US 2002-391360P

P 20020625

US 2003-458399

A 20030610

WO 2003-US20792

W 20030624

AB Synthesis gas is produced by a cyclic reforming and re-heating process including reforming a hydrocarbon feed over a catalyst to synthesis gas in a 1st zone of a bed and the 2nd step reheats this 1st zone. A hydrocarbon feed is introduced to a bed along with CO₂ and optionally steam where it is reformed into synthesis gas. The synthesis gas is collected at a 2nd zone of the bed and an oxygen-containing gas is then introduced to this 2nd zone of the bed and combusted with a fuel, thereby reheating the 1st zone to sufficient reforming temps. Addnl., a noncombusting gas can also be introduced to the 2nd zone to move heat from the 2nd zone to the 1st zone. The reforming catalyst can contain noble metals, group VIII metals, Ag, Ce, Cu, La, Mo, Mg, Sn, Ti, Y, and Zn. The packing materials of the 1st and 2nd zones can consist of magnesium aluminum silicates, aluminum silicate clays, mullite, alumina, silica-alumina, or zirconia.

=> d his

(FILE 'HOME' ENTERED AT 10:45:03 ON 17 AUG 2005)

FILE 'STNGUIDE' ENTERED AT 10:45:12 ON 17 AUG 2005

FILE 'HOME' ENTERED AT 10:45:19 ON 17 AUG 2005

FILE 'CAPLUS' ENTERED AT 10:45:36 ON 17 AUG 2005

L1 10 S PRESSURE SWING REFORM?

L2 9 S L1 AND SYNTHESIS GAS

L3 8 S L2 AND STEAM REFORM?

=> s l1 not l3

L4 2 L1 NOT L3

=> d l4 ibib ab 1-2

L4 ANSWER 1 OF 2 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2005:738541 CAPLUS

TITLE: Pressure swing reforming
of liquid fuels for hydrogen production

AUTHOR(S): Socha, Richard F.; Berlowitz, Paul J.; Hershkowitz,
Frank

CORPORATE SOURCE: Corporate Strategic Research, ExxonMobil Research and
Engineering Company, Annandale, NJ, 08801, USA

SOURCE: Abstracts of Papers, 230th ACS National Meeting,
Washington, DC, United States, Aug. 28-Sept. 1, 2005
(2005), FUEL-037. American Chemical Society:
Washington, D. C.

CODEN: 69HFCL

DOCUMENT TYPE: Conference; Meeting Abstract; (computer optical disk)

LANGUAGE: English

AB Pressure Swing Reforming (PSR) is a new process for the production of hydrogen from hydrocarbon fuels. It was first demonstrated in our labs. using methane as the fuel. We have now extended the operation to a variety of gasoline-range hydrocarbons having sulfur contents up to 320 ppm. PSR uses a cyclic reverse-flow reactor to generate high-pressure (e.g. 1000 kPa) undiluted synthesis gas (CO+H₂) at high temperature (up to about 1200°C) over a reforming catalyst but keeps the inlet and outlet gases at a relatively low temperature (less than 400°C). In the forward direction, steam and fuel are introduced for reforming for a period of about 3 s to 3 min. The process flow is then reversed and waste fuel is burned on the catalyst to supply the heat

of reaction for the next reforming cycle. This minimizes the need for external heat exchange, making the process highly compact, and ideally suited to small systems incorporating a fuel cell.

L4 ANSWER 2 OF 2 CAPLUS COPYRIGHT 2005 ACS on STN

ACCESSION NUMBER: 2004:1080308 CAPLUS

DOCUMENT NUMBER: 142:41241

TITLE: Reforming unit for hydrocarbons and alcohols
integrated with pressure-swing adsorption for
manufacture of hydrogen fuel for fuel cells

INVENTOR(S): Okada, Hiraku; Machida, Hiroshi; Yoshida, Nobuyoshi

PATENT ASSIGNEE(S): Honda Motor Co., Ltd., Japan

SOURCE: U.S. Pat. Appl. Publ., 14 pp.

CODEN: USXXCO

DOCUMENT TYPE: Patent

LANGUAGE: English

FAMILY ACC. NUM. COUNT: 1

PATENT INFORMATION:

PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
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US 2004250472	A1	20041216	US 2004-869173	20040616
JP 2005008434	A2	20050113	JP 2003-170961	20030616
PRIORITY APPLN. INFO.:			JP 2003-170961	A 20030616

AB A hydrogen-rich fuel gas, suitable for use in fuel cells, is manufactured by reforming of hydrocarbon or alc. fuels by: (1) passing the reformed fuel gas through a pressure-swing adsorption mechanism to remove combustible impurities and obtain the hydrogen-rich gas, and (2) combusting the impurities as a heat source, in which the amount of combustion air to the combustion chamber is controlled by measuring the changes in released heat energy from the impurities. An electronic control unit is installed to control the amount of combustion air to the furnace for combustion of the impurities recovered from the pressure-swing adsorption unit.